TSUNAMI RISK REDUCTION FOR THE UNITED STATES: A FRAMEWORK FOR ACTION

National Science and Technology Council

A Joint Report of the Subcommittee on Disaster Reduction and the United States Group on Earth Observations

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1. EXECUTIVE SUMMARY

Following the Indian Ocean tsunami on December 26, 2004, the President moved to protect lives and property by launching an initiative to improve domestic tsunami warning capabilities. This plan, developed under the auspices of the National Science and Technology Council, places the President's initiative in the context of a broad national effort of tsunami risk reduction and United States participation in international efforts to reduce tsunami risk worldwide.

Although the frequency of damaging tsunami in the United States is low compared to many other natural hazards, the Indian Ocean event was a reminder that the impacts can be extremely high. Recognizing the potential geographic links to other hazards such as hurricanes, volcanoes, and earthquakes, the framework for tsunami risk reduction incorporates an all-hazards approach and builds upon existing hazard programs.

Successfully developing tsunami-resilient communities depends on enhanced Federal, State and local capabilities in each of the following seven areas:

Determining the Threat. Determining the threat facing coastal communities requires characterization of local and distant tsunami sources and estimation of tsunami frequency.

Hazard identification uses understanding of an area's history of tsunami events to determine the frequency and severity of events that can be expected in the future. Once the hazard has been identified, risk assessment uses advanced scientific modeling to estimate tsunami impacts, loss of life, threat to public health, structural damage, environmental damage, and economic disruption that could result from specific tsunami scenarios.

Actions are required at all levels of government to complete tsunami risk assessments for the Nation's coastal areas.

Preparedness. Preparedness is the advance capacity to respond to the consequences of a tsunami by having plans in place so that people know what to do and where to go if a tsunami warning is issued or a tsunami is observed. This can be achieved through development of additional TsunamiReady communities that have plans, enhanced communications and heightened awareness of their citizens. This will increase resilience to tsunami events, reduce economic losses and shorten recovery periods.

Timely and Effective Warnings. Federal agencies utilize earthquake and volcano monitoring systems, deep ocean buoys and other capabilities to gather as much information as possible about a potential tsunami. This essential data is then provided to analysis centers for the assessment of the immediate tsunami threat. Timely and accurate warnings must then be disseminated in clear and actionable terms to managers and a ready public.

Mitigation. Mitigation involves sustained actions taken to reduce or eliminate the long-term risk to human life and property based on tsunami risk assessments. This includes planning and zoning to manage development in areas particularly at risk for tsunami, embracing tsunami resistant construction, and protecting critical facilities and infrastructure.

Public Outreach and Communication. Communication with the public is critical to help them understand the nature of the tsunami hazard, the risks to personal safety and property and the steps to reduce those risks. Key components include raising public awareness and effecting behavioral change in the areas of mitigation and preparedness; the deployment of stable, reliable, and effective warning systems; and the development of effective messaging for inducing favorable community response to mitigation, preparedness and warning communications.

Research. A continuing broad scientific research effort is needed to improve our understanding of tsunami processes and impacts, and to develop more efficient and effective risk assessment, risk communication, prediction, preparedness, mitigation and warning measures. Research results can improve and make all of the activities within this plan more cost-effective.

International Coordination. Partnerships with international organizations and other countries through bilateral and multilateral agreements are required actions to reduce the threat and impact of tsunami. The recent events across Southern Asia demonstrate that tsunamis can have global implications, engendering economic, political and social consequences worldwide. The United States will provide technical expertise and assistance to facilitate development of an Indian Ocean tsunami warning system, strive to ensure interoperability between the United States' system and other regional tsunami warning systems, and participate in appropriate international organizations. Through effective international cooperation we can increase national tsunami safety and reduce international losses, thus improving global stability and minimizing future costs of aid and recovery.

The National Tsunami Hazard Mitigation Program, a partnership involving relevant Federal agencies and coastal states, provides the organizational framework needed to execute the President's tsunami initiative in the near-term and shall develop, coordinate and sustain an effective and efficient tsunami risk reduction effort in the United States over the long term. The Subcommittee on Disaster Reduction should be briefed on an annual basis and shall partner with the National Tsunami Hazard Mitigation Program to consider options for a sustained national tsunami risk reduction effort. Specific actions called for in this plan are:

- Develop standardized and coordinated tsunami hazard and risk assessments for all coastal regions of the United States and its territories.

- Improve tsunami and seismic sensor data and infrastructure for better tsunami detection and warning.

- Enhance tsunami forecast and warning capability along our coastlines (Pacific, Atlantic, Caribbean, and Gulf of Mexico) by increasing the number of Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys, tide gauges, and seismic sensors feeding real-time data into on-line forecast models.

- Ensure interoperability between U.S. national system and other regional tsunami warning systems.

- Provide technical expertise and assistance, as appropriate, to facilitate development of

international tsunami and all-hazard warning systems, including for the Indian Ocean.

- Encourage data exchange and interoperability among all regional tsunami and all-hazard warning systems, such as The Intergovernmental Oceanographic sub-commission for the Caribbean (IOCARIBE).

- Promote development of model mitigation measures and encourage communities to adopt construction, critical facilities protection and land-use planning practices to reduce the impact of future tsunamis.

- Increase outreach to all communities, including all demographics of the at-risk population, to raise awareness, improve preparedness, and encourage the development of tsunami response plans.

- Conduct an annual review of the status of tsunami research and develop a strategic plan for tsunami research in the United States.

2. INTRODUCTION

2.1 PURPOSE

The Indian Ocean tsunami of December 26, 2004 gave rise to levels of loss and grief unprecedented in the history of natural hazards in the region. Much of the tsunami impact was due to a lack of public awareness, effective warning systems, and implementation of mitigation measures. In addition to providing immediate financial and developmental aid to the affected countries, the President proposed a $37.5 million initiative to improve domestic tsunami warning systems. The first installment of that initiative was included in the Emergency Supplemental Appropriations Act of 2005, which the President signed into law on May 11, 2005. The Act appropriated approximately $24 million to expand national tsunami detection and earthquake monitoring capabilities, thus improving tsunami protection for the United States and the world. The President also requested increases in the National Oceanic and Atmospheric Administration and U.S. Geological Survey in his fiscal year 2006 budget proposal.

Recognizing the complexity and scope of the sustained efforts needed to ensure tsunami risk reduction in the decades to come, additional actions are needed in hazard assessment, warning, response planning, and new or improved actions in public awareness, mitigation, and research. All of these efforts require sustained coordination, attention and support on the Federal, state and local level.

This document was prepared by a joint working group of the Subcommittee on Disaster Reduction and the United States Group on Earth Observations, both under the leadership of the National Science and Technology Council. The principal Federal agencies involved in the implementation of this plan are the National Oceanic and Atmospheric Administration (NOAA), the United States Geological Survey (USGS), and the Department of Homeland Security's Federal Emergency Management Agency (FEMA). Other agencies playing important roles are the Department of State, the United States Agency for International Development (USAID), the National Guard Bureau, and the National Science Foundation (NSF).

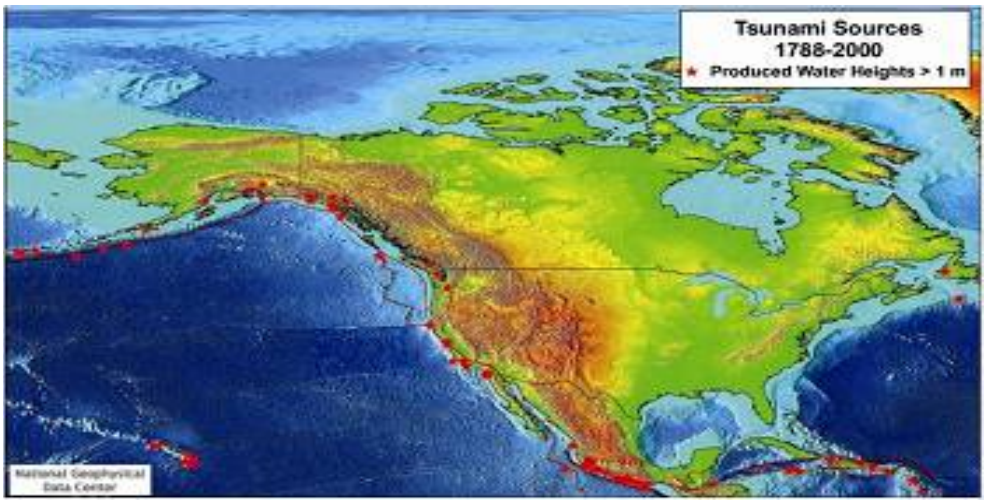


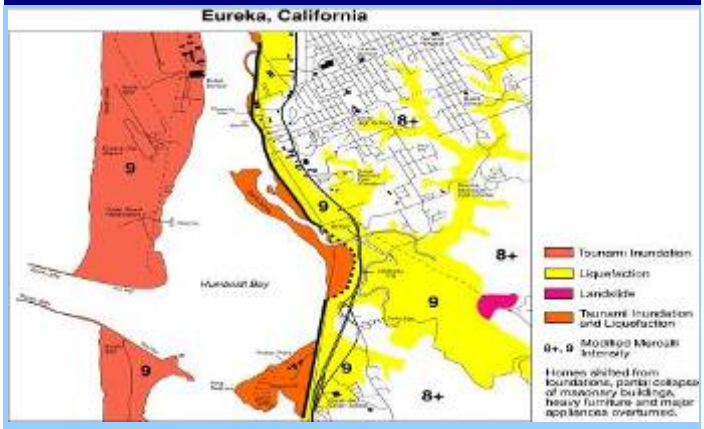
Figure 1. Tsunami hazard for the United States is dominated by the earthquake zones capable of generating tsunamis in the Alaska-Aleutian Seismic Zone, the Cascadia Subduction Zone, near Hawaii, and Puerto Rico.

2.2 THE TSUNAMI THREAT

The Problem. United States coastal communities are threatened by tsunamis generated by both **local** sources and **distant** sources. Local tsunamis give residents only a few minutes to seek safety. Tsunamis of distant origins give residents more time to evacuate the threatened coastal areas, but require timely and accurate tsunami forecasts of the hazard to avoid costly false alarms. For example, United States residents in Alaska can experience a local earthquake—the most common cause of tsunamis—and local tsunami, while residents of Hawaii and the west coast may experience this event as a distant tsunami. Similarly, Pacific Northwest residents can experience a local tsunami that also may have an impact on the distant states of Alaska and Hawaii. A tsunami in the Caribbean could result in a local tsunami for Puerto Rico that also impacts Atlantic coast communities in the Southeast as a distant tsunami. Of the two, local tsunamis pose a greater threat to life because of the short time between generation and impact. The challenge is to design a tsunami hazard mitigation program to protect life and property from two very different types of tsunami events.

The Greatest Threat—Local Tsunamis Generated Near U.S Coastline. The Cascadia Subduction Zone threatens California, Oregon, and Washington with devastating local tsunamis (Figure 1) that could strike the coast within minutes[1]. Recent estimates indicate a fifteen percent chance of a Cascadia earthquake occurring within the next 50 years[2]. The Alaska and Aleutian Seismic Zone also has been recognized as a region with very high seismic potential[3]. United States seismologists

Earthquake Spurs First Local Tsunami Hazard Map



This map identifies areas of tsunami flooding, liquefaction, landslides, and intense ground shaking. If the tsunami is generated by a local, major earthquake near Eureka, then Highway 101 probably will be damaged by the liquefied soils to the south. Evacuation then would be feasible only to the north on Highway 101.

In April 1992 a small tsunami was generated at the southern end of the Cascadia Subduction Zone by a large (magnitude 7.1) earthquake near Cape Mendocino, California. This tsunami arrived at Eureka, California only minutes after the earthquake origin time. During a post-earthquake scientific meeting sponsored by FEMA on the Cape Mendocino earthquake/tsunami, participants recommended the immediate production of local tsunami inundation maps for Northern California coastal communities at risk. Tsunami preparedness was deemed to be of such high importance and urgency that the project was funded by FEMA and NOAA to produce tsunami inundation maps for Eureka and Crescent City, California. FEMA also funded an earthquake scenario study of Northern California. The combined study produced the first comprehensive assessment of the nearby earthquake and local tsunami risk to a coastal community. The first-of-a-kind map is illustrated in Figure 2, which clearly shows areas susceptible to tsunami flooding, earthquake shaking intensity, earthquake-induced liquifaction, and earthquake-triggered landslides.

The Eureka tsunami study can be considered the prototype and model for the application of existing technology to local tsunami hazard assessment. These local tsunami hazard maps were incorporated into the emergency plans of Eureka, California and formed the basis of an ongoing education program. The building blocks are partially in place—inundation maps exist for all coastal communities in Washington and Oregon and for selected communities in Alaska, California and Hawaii.

have predicted an eighty-four percent probability between 1988 and 2008 of a major earthquake with magnitude greater than 7.4 in Alaska[4]. Although no estimates of recurrence are available for the Puerto Rico Subduction Zone, local tsunamis have damaged Puerto Rico in the past century[5]. When any of these earthquakes occur, and a destructive tsunami is generated, nearby low-lying coastal areas can expect flooding within minutes.

In addition to earthquake sources, locally significant tsunamis can be generated by submarine landslides (possibly earthquake-triggered) and volcanic eruptions or edifice collapse. This threat can affect all United States coastal areas, including island territories such as the Northern Marianas.

This threat was nearly a reality on June 14, 2005 when a small non-destructive tsunami was generated by a large earthquake off the California coastline. The investments in hazard assessment, warning guidance, and mitigation were all tested in this event and demonstrated their effectiveness under real tsunami threat conditions. Following the earthquake on June 14, NOAA's tsunami warning center issued a warning and the residents of Crescent City, California began to evacuate. Investments in upgrading the real-time seismic network and the educational and mitigation programs implemented by the State of California over the past 7 years, including a tsunami evacuation map and street signs to guide evacuation made this efficient response possible. Within an hour, the warning was cancelled because a network of real-time tsunami detection buoys off the California coastline provided the necessary data to cancel the warning knowing the tsunami posed no threat to the coastal residents in this area. Despite this success at Crescent City, however, the event also demonstrated that other parts of the U.S. Pacific Coast are not as well protected and more work remains to be done.

The Silent Threat—Tsunamis Generated at a Distance. The contiguous United States has suffered damage from tsunamis originating in Chile, Japan, Russia, and Alaska[6]. If an earthquake in Alaska generated a major tsunami, Alaskan shores would be flooded within minutes, while the coasts of Hawaii, Washington, Oregon, and California would be hit within 5 hours of the event[7]. Due to the abundance of remote sources capable of generating a distant tsunami, the probability of damage from a distant tsunami is much greater than a local tsunami in the Pacific Ocean because of the abundance of remote sources capable of generating a distant tsunami. Managing the threat of distant tsunamis requires an accurate, timely forecast to allow coastal populations to evacuate in time to save lives. Issuing unnecessary warnings may result in affected populations ignoring future warnings, while the danger in issuing too few warnings places coastal populations at risk. Recent measurement and modeling technologies produce a more accurate forecast of distant tsunamis, thus reducing false alarms. Tsunami forecasting requires real-time measurement of the tsunami in the deep ocean that can be assimilated into numerical models in time to issue a forecast to coastal populations. Such a system provides accurate forecasts that avoid false alarms while providing warning of destructive tsunamis in time to safely evacuate vulnerable areas.

3. DEVELOPING TSUNAMI-RESILIENT COMMUNITIES

3.1 DETERMINING THE THREAT

Definition. The first step toward developing tsunami-resilient communities is to determine the threat they face. Such a determination begins with assessing the hazard by characterizing potential local and distant tsunami sources (including offshore earthquakes, submarine landslides, and oceanic volcanoes), estimating tsunami frequency through detailed analysis of past events, and developing realistic models of tsunami effects. A risk assessment can then be produced by combining knowledge of the hazard with information on the coastal vulnerability, including the population infrastructure, lifelines, economic activities, and level of local preparedness for such events. These assessments are the fundamental starting point for government officials, private interests, and the general public to begin preparation of community-specific plans to reduce vulnerability.

Complete and effective system. Risk assessments of the tsunami threat for all exposed coastal areas should be performed. These assessments should identify the inventory and value of at-risk structures, infrastructure and population present, the fragility of the structures exposed to the hazard, and categorization and presentation of the resulting damage and casualties. Graphical information products or maps showing the areas exposed to tsunami inundation and maximum tsunami related water depths and velocities in these areas, should be included and available at the appropriate scale for all levels of government to use in preparedness activities.

Current capability. Tsunami hazard exists on the Pacific, Atlantic, Caribbean, and Gulf coasts of the United States. Our understanding of the level of risk associated with this hazard is more advanced for the Pacific and Caribbean coasts, but is minimal or non-existent for the other coasts. Tsunami risk assessments exist for many communities with substantial populations at risk in California, Alaska, Hawaii, Oregon, and Washington. These states are undertaking individual efforts to generate inundation maps that identify areas and depths of tsunami flooding or run up. There are no tsunami risk assessments for the rest of the United States coastal areas.

Needed actions. Actions are required at all levels of government to complete tsunami risk assessments for the national coastal areas. Tsunami risk assessments should take into account existing assessments of storms, flooding, earthquakes, volcanoes, and other potential sources. These assessments should be cast in terms of extreme scenarios or annual probabilities of occurrence or both. To avoid confusion, these assessments should consider and take into account, if possible, the methodologies and terminologies used in the assessments of other natural hazards (e.g., the probabilistic approach used for seismic hazard assessment).

Roles and responsibilities.

NOAA – Provide leadership, technical assistance, and technology transfer to complete tsunami hazard identification and risk assessments for all coastal regions of the United States. Provide mapping and inundation modeling from the Pacific Marine Environmental Laboratory in coordination with USGS.

USGS – Support NOAA by providing earthquake, landslide and volcano source characterizations and frequency estimates and modeling of tsunami effects in support of tsunami risk assessments. For all United States coasts and island territories, carry out

research on tsunami impact models and post-event surveys of coastal flooding, sediment transport, ecological impacts, and other tsunami consequences.

FEMA/NOAA/USGS develop a coordinated risk assessment tool (e.g. Hazards U.S., or HAZUS, a standardized loss estimation software package available from FEMA for earthquakes, high winds and flooding) for effective use in tsunami risk assessments.

States and Territories – Through voluntary and cooperative arrangements with federal agencies, provide requirements for, and reviews of, tsunami hazard identification and risk assessments. Provide data and information in cooperation with NOAA and USGS.

3.2 PREPAREDNESS

Definition. Preparedness is the advance capacity to respond to the consequences of a tsunami. This means having plans in place that tell people what to do and where to go if a tsunami warning is issued or a tsunami is observed. This will increase resilience to tsunami events, reduce economic losses and shorten recovery periods. States, local governments, communities, businesses, schools, public facilities, families and individuals should have preparedness plans.

Complete and effective system. A comprehensive National Response Plan (NRP) and state and local tsunami response programs will ensure a hierarchy of coordination and communication through all levels of government. In addition, evacuation maps and evacuation routes should be well known by residents and clearly marked for visitors in all coastal areas. Response plans need to account for the demographics of the at-risk population—especially the poor, seniors, and the disabled, and individuals in ill health—ensuring the entire at-risk population has a mechanism (and is aware of the mechanism) to obtain a safe haven.

Current capability. Many communities in states in the Pacific Northwest, Alaska, and Hawaii are TsunamiReady (i.e. they have tsunami response plans and conduct exercises on a regular basis). TsunamiReady communities need to be established in at-risk coastal communities on the Atlantic, Gulf, and Caribbean coasts.

Needed actions. The NRP should be used to comprehensively coordinate response to major incidents and disasters, including tsunami response and recovery. Tsunami response readiness should be established in threatened communities on the Atlantic, Gulf, and Caribbean coasts while maintaining tsunami response readiness in communities on the Pacific coast. End-to-end testing should be in place to ensure that warning and dissemination systems are operating properly; warnings and notices are received and understood; and the entire demographics of the at-risk population—especially the poor, seniors, the disabled, and individuals in poor health—have a mechanism (and is aware of the mechanism) to obtain a safe haven.

Roles and responsibilities.

NOAA – Increase outreach to communities at risk to improve preparedness. Support state and local governments in their efforts to attain TsunamiReady status.

NOAA, with active participation of state and local agencies – implement and conduct routine end-to-end testing of warning dissemination and notification systems.

NOAA/USGS/FEMA – Support the states in their efforts to develop tsunami response plans in all threatened communities to include all United States coastal states, Territories, and Commonwealths. FEMA's Mitigation and Preparedness Divisions should continue to work with NOAA to improve community preparedness.

FEMA – Provide assistance to states to promote and improve existing relationships for preparedness and planning.

State, Territory, Tribal and local governments – Cooperate with federal agencies to develop response plans, build awareness of and readiness for tsunami hazards in coastal communities and conduct routine exercises that maintain preparedness.

3.3 TIMELY AND EFFECTIVE WARNINGS

Definition. Federal agencies, such as NOAA and USGS, utilize earthquake and volcano monitoring systems, deep ocean buoys and other capabilities to gather as much information as possible about the what, when, and where of a potential tsunami. These essential data are provided to analysis centers for the assessment of the immediate tsunami threat. Timely and accurate warnings are then disseminated in clear and actionable terms to disaster managers and the general public. NOAA's tsunami warning centers generate warning bulletins using seismic and water depth data from monitoring instruments, real-time communications systems, and data analysis procedures and facilities. These systems determine the occurrence of a tsunami-capable earthquake (or other event), if a tsunami has been generated, predict when the tsunami will reach populated areas, and its likely impacts. This information is quickly disseminated through a variety of means to officials at Federal, state and local emergency management agencies and to the public – in time for life saving actions to be taken. State and local emergency management agencies provide evacuation orders or other response instructions to local communities through multiple channels that may include radio and TV broadcasts, town sirens, and police and fire station loudspeakers.

The Economic Impact of Tsunami Warnings

Following an earthquake on November 17, 2003, NOAA's tsunami warning center issued a warning within five minutes of the earthquake. Within an hour, the warning was cancelled because real-time tsunami detection buoys off the Alaska coastline provided the necessary data to inform decision makers that a tsunami was not imminent. The early cancellation of this warning avoided an unnecessary evacuation of Hawaii coastlines, saving millions of dollars.

A similar event occurred in 1986, but, without the deep ocean data the warning was not cancelled until after an evacuation had taken place. The Hawaii Department of Business, Economic Development and Tourism estimated the cost to Hawaii in lost productivity in 1986 was $40M. Adjusted for inflation, a similar evacuation in 2003 would have cost Hawaii $70M in lost productivity.

Complete and effective system. The USGS National Earthquake Information Center, the NOAA Tsunami Warning Centers, and the FEMA Emergency Operations Centers should be staffed on a 24x7 basis by personnel trained to cope with an immediate tsunami threat. The USGS National Earthquake Information Center should transmit international, national and regional seismic data to the Tsunami Warning Centers, where it would be combined with other seismic data and data from coastal and deep-ocean sea level sensors. The Tsunami Warning Centers should analyze the combined data and, if appropriate, transmit timely and accurate tsunami forecasts and warnings to government officials via a robust communications networks. These officials, in turn, must have access to the reliable and capable communication and broadcast systems necessary to notify

emergency managers at all government levels.

The tsunami warning system also will benefit from the work and recommendations of the Task Force for Effective Warnings recently convened by the National Science and Technology Council and Homeland Security Council.

Current capability.
NOAA's National Weather Service operates and administers the tsunami-warning program for the United States. The Pacific Tsunami Warning Center in Ewa Beach, Hawaii has mission responsibility as the operational center for the Tsunami Warning System in the Pacific, as the United States National Tsunami Warning Center for United States national interests throughout the Pacific basin and also as the Hawaii Regional Tsunami Warning Center. The West Coast and Alaska Tsunami Warning Center in Palmer, Alaska, has responsibility as the Alaska and United States West Coast Regional Tsunami Warning Center within the United States and for the Canadian Province of British Columbia. Following the Indian Ocean tsunami in December 2004, the West Coast and Alaska Tsunami Warning Center was directed to also provide tsunami warning to the United States Atlantic, and Gulf of Mexico coasts as well as dissemination of information bulletins for Atlantic Canada. The Pacific Tsunami Warning Center is providing on an interim basis, warning information bulletins to focal points in the Indian Ocean region and to the Caribbean.

The FEMA Operations Center/FEMA Alternate Operations Center use the National Warning System on a 24x7 basis to convey warnings to Federal, state and local governments, as well as the military and civilian populations. The information disseminated by the FEMA Operations Center/ FEMA Alternate Operations Center via the National Warning System include information about terrorist actions, aircraft incidents or accidents, earthquakes, floods, hurricanes, nuclear incidents or accidents, severe thunderstorms, tornadoes, tsunamis and winter storms. The National Warning System allows issuance of warnings to all designated stations nationwide or to selected stations as dictated by the situation. The FEMA Alternate Operations Centers/FEMA Alternate Operations Centers conduct tests of the National Warning System twice daily to ensure connectivity to the regional and state warning points. Each state has a Primary State Warning Point and Alternate State Warning Point that exercises operational control of the National Warning System within that State. The Primary State Warning Point is staffed 24x7 and is in contact with its assigned FEMA Operations Center or FEMA Alternate Operations Center, as applicable. The state warning points are responsible for dissemination of warnings to local government officials.

USGS and NSF operate global, national and regional-scale seismic monitoring networks in partnership with other countries, states and territorial agencies and universities. Data from these networks are sent in real time to the USGS National Earthquake Information Center and regional network centers for analysis of earthquake location, magnitude, source characteristics, and potential impacts. Earthquake data and information are also transmitted continuously to the NOAA Tsunami Warning Centers. Earthquake alert information is sent to FEMA, the Department of Defense, other domestic agencies, state emergency centers, the news media, infrastructure managers, and the general public.

Standard procedures and communication links exist between NOAA, FEMA, USGS, and state agencies for the transmission of data and warnings related to potential or actual tsunami situations.

Needed actions. To provide the most accurate predictions and warning guidance, the following specific actions should be taken: (Note: several of these actions are currently being implemented under the President's directive of January, 2005.)

- The Tsunami Warning Centers and USGS National Earthquake Information Center must attain and maintain robust 24x7 operations;

- Increase availability of timely and accurate seismic data through expansion of seismic coverage in the Caribbean, additional telemetry and maintenance for the Global Seismographic Network, and modernization and completion of regional seismic networks in Alaska, California, Hawaii, Oregon and Washington;

- Upgrade existing and deploy new DART buoys in the Pacific, Atlantic and the Caribbean;

- Complete the installation and upgrade of coastal sea level monitoring stations;

- Expand existing information dissemination systems, such as Emergency Managers Weather Information Network and RAdio and InterNET Communications Meteorological and Climate Information, and incorporate their use into an evacuation notification system;

- Complete all modeling efforts for inundation maps;

- Continue to improve the forecast models; and,

- Regularly review the system requirements to ensure adequate sensor coverage.

Roles and responsibilities. Predicting a tsunami and issuing warning guidance is chiefly a responsibility of the federal government:

FEMA – The FEMA Operations Center issues warning messages over the National Warning System.

FEMA/NOAA – Expand and fortify the emergency communications systems used to disseminate, tsunami warnings and information.

NOAA – (1) Establish in-office 24x7 warning center operations; (2) Complete deployment of the DART buoys and coastal sea level sensors; (3) Complete all current inundation and forecast modeling efforts; (4) In coordination with USGS, upgrade local seismic networks in Alaska, California, Hawaii, Oregon and Washington; (5) In coordination with state and local governments, establish requirements for tsunami warning dissemination systems where they do not exist.

USGS – (1) Establish robust 24x7 National Earthquake Information Center operations; (2) Add Global Seismographic Network stations in the Caribbean area, and integrate data from new and upgraded stations into the National Earthquake Information Center and the Puerto

Rico Seismic Network; (3) In coordination with NSF, enhance the real-time seismic information delivery from the Global Seismographic Network by increasing station uptime and telemetry systems; and (4) Upgrade real-time earthquake data analysis systems to improve rapid evaluation of the tsunami threat from local, near-shore earthquakes.

States and Territories – Review and suggest improvements to warning guidance products developed by Federal agencies.

3.4 MITIGATION

Definition. Mitigation involves sustained actions taken to reduce or eliminate the long-term risk to human life and property based on tsunami risk assessments. This includes planning and zoning to manage development in areas particularly at risk for tsunami, developing and enforcing tsunami resistant construction and protecting critical facilities and infrastructure.

Complete and effective system. All sectors of communities with a tsunami risk should understand the nature of the hazard, become aware of long-term measures to reduce risk of tsunami losses, and take appropriate actions. Tsunami resistant elements should be included in building codes, building design and construction practices. Utilities and critical facilities should be protected to reduce exposure to the tsunami threat.

It is critical that efforts to improve tsunami mitigation build on the work done or ongoing in relation to other natural hazards (floods, earthquakes, hurricanes, etc.). An all-hazards approach must be taken.

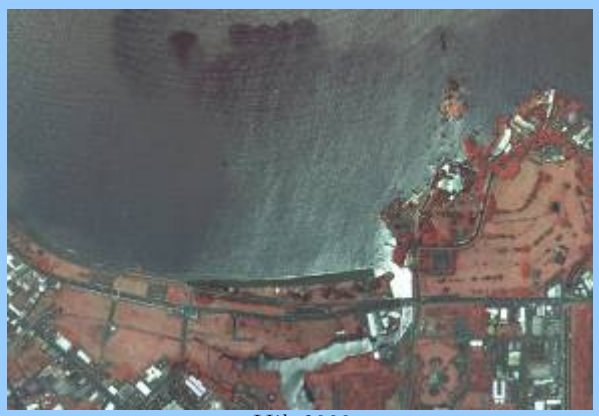
Current capability. The Disaster Mitigation Act of 2000, commonly known as the 2000 Stafford Act amendments, was signed into law on October 30, 2000 establishing a national program for pre-disaster mitigation. Under this program communities may receive federal funds for mitigation projects or to develop a mitigation plan. Most communities have some local multi-hazard mitigation plans in place, some of which include tsunami mitigation planning.

Land Use Decisions to Reduce Loss of Life

There are practical decisions concerning the continued use of land threatened by tsunami that can greatly decrease the potential for life loss. One example comes from the city of Hilo, Hawaii. As described in the book "Tsunami" by Walter C. Dudley and Min Lee:

Following the 1956 tsunami, the strip of land between Kamehameha Avenue and the bay front had been converted into a recreation and parking area that was to serve as a buffer zone against future tsunamis.... Just 8 days after the 1960 tsunami, the Hawai'i Redevelopment Agency was established. The ocean side buffer zone was expanded and a landfill plateau was constructed, raising the inland border of the greenbelt 26 feet above sea level.

Hilo 1954



Hilo 2000

Needed actions. Long-term loss reduction measures should include construction practices that resist tsunami effects. The construction practices that resist earthquake shaking and flooding may apply, in part, to resisting tsunami impacts. Currently, there are generally no provisions in the model building codes, on which many local and state building codes are based, for tsunami-resistant construction. These model code elements should be developed. If possible, critical facilities, utilities, and transportation and other infrastructure elements should be sited, or re-sited, in areas not likely to be affected by tsunamis. Community land use planning can be used to avoid exposure to tsunami dangers. It may be difficult to implement land use planning measures in tourist areas, where beach access and ocean views are valued; nevertheless, efforts must be made to do so.

Roles and responsibilities.

FEMA/NOAA/USGS with active involvement of state and local agencies – Promote the development of model mitigation measures. These materials should be designed in cooperation with state and local government for use and implementation at the community level.

State, Territory and local governments – Oversee the development and implementation of mitigation programs.

Communities – Adopt construction, critical facilities protection, and land use planning practices to reduce impacts of future tsunamis.

3.5 PUBLIC OUTREACH AND COMMUNICATION

Definition. Communication with the public is critical to help them understand the nature of the tsunami hazard, the risks to personal safety and property, and the steps to reduce those risks. Risk communication includes raising public awareness and effecting behavioral change in the areas of mitigation and preparedness; the deployment of stable, reliable, and effective warning systems; and the development of effective messaging for inducing favorable community response to mitigation, preparedness and warning communications.

Complete and effective system. All sectors of communities with a tsunami risk should understand the nature of the hazard, become aware of measures to reduce risk of tsunami losses, and take appropriate actions. Public awareness should include education in schools, signage on highways and beaches, notices in hotel rooms, periodic newspaper inserts and other means of information dissemination. It is critical that efforts to improve tsunami public awareness and mitigation build on the work done or ongoing in relation to other natural hazards (floods, earthquakes, hurricanes, etc.). An all-hazards approach must be taken. In risk communication, many of the countermeasures against one hazard will prove effective against another. Common terminologies, warning levels, and emergency preparedness measures must be used.

A comprehensive National Warning System will ensure a redundant means of communicating warnings and evacuations to residents and visitors in all coastal areas.

Current capability. As part of the National Tsunami Hazard Mitigation Program, Pacific coastal areas, states and local communities have spent several years increasing awareness of the tsunami threat. Focused survey results show that understanding of tsunami risk and warning procedures by emergency managers in several of these communities has greatly increased because of these efforts.

Tsunami signage and evacuation brochures for the public and visitors have been implemented by these states. On the other hand, it is not clear that the tourism industry and interests have adequately emphasized the tsunami threat and safety measures.

The TsunamiReady Program and National Tsunami Hazards Mitigation Program Mitigation Subcommittee have also improved community awareness and preparedness.

Public awareness programs for communities in Atlantic, Gulf, and Caribbean coastal states and territories are just beginning.

Needed actions. In all coastal areas threatened by tsunamis there should be tsunami education and awareness programs focusing on the immediate and long-term actions that can be taken to save lives and property. Since many coastal areas attract transient vacationers, public education efforts must include non-residents as well as the indigenous population. Increased emphasis and expansion of the TsunamiReady Program will greatly assist in community awareness and preparation.

Roles and responsibilities.

NOAA/FEMA/USGS with active involvement from state and local agencies – Promote the development of model public awareness campaigns. These materials should be designed in cooperation with state and local government for use and implementation at the community level.

NOAA/FEMA/USGS – Develop and deploy enhancements to emergency communications systems/capabilities.

NOAA and FEMA in active partnership – Improve awareness by increasing outreach to communities at risk through the TsunamiReady Program and FEMA's Mitigation Division

State, Territory and local governments – (1) Cooperate with federal agencies to build awareness of tsunami hazards in coastal communities and conduct routine exercises that maintain public awareness; (2) Oversee the development and implementation of public awareness programs.

Communities – Understand the applicable tsunami hazards and take steps to make permanent and transient populations aware of the hazard.

3.6 RESEARCH

Definition. Research refers to those scientific studies and analyses that are needed to improve our understanding of tsunami processes and impacts. Research is also needed to develop more accurate models as well as efficient and effective warning and mitigation measures.

Complete and effective system. Research and development is needed in the following areas on the topics identified:

Determining the Threat. We must improve our understanding of tsunami sources of all types. Deterministic models of how these sources generate tsunamis and probabilistic models of how often they are likely to occur should be developed. Field surveys are needed

to identify past tsunami impacts for specific locations and to characterize potential tsunami sources including offshore faults, submarine landslides and island volcanoes. Geological studies including stratigraphic analyses of prehistoric tsunami deposits to determine past tsunami frequency and size, as well as comprehensive documentation of the coastal impacts of modern tsunamis are needed. Improved models of tsunami run up and flooding are needed to determine tsunami impacts and to develop effective countermeasures.

Preparedness. Scenario exercises should be developed to evaluate response capabilities and deficiencies, establish best practices for tsunami planning in the context of all-hazards and evaluation procedures designed to measure the effectiveness of the planning. Means are also needed to test tsunami awareness levels.

Timely and Effective Warnings. It is crucial to develop new analytical techniques for seismic signals that identify the tsunami potential of a nearby earthquake. New analyses of tsunami records at coastal and deep ocean locations are needed to improve forecasting capabilities. Evaluations of real-time communications technologies and warning dissemination methods are needed, and if warranted, improved technologies and techniques developed. Research is also needed on advanced ocean height and seismic sensors.

Mitigation. Research is needed to establish construction and retrofit practices for threatened areas. Engineering research on tsunami resistant construction and land use practices for resilient communities is lacking and must be addressed.

Public Outreach and Communication. Applied research is needed to develop effective standard materials, message, and communications for tsunami awareness education.

Research efforts are needed on the societal response to tsunami warnings. Social and behavioral science tools are necessary to measure risk communication effectiveness of existing tsunami programs and products to various target groups in the community including decisions makers, citizens, businesses (the tourism industry in particular since their clients make up a large portion of potentially impacted people who will require local resources following an event) and visitors.

Current capability. NOAA supports a national tsunami research program dedicated to developing tsunami hazard assessment and forecast tools as well as developing and deploying deep ocean tsunami sensors to improve tsunami warning.

Tsunami-related research is supported by the USGS and NSF as components of more broadly focused hazard efforts, such as the National Earthquake Hazards Reduction Program (NEHRP). The USGS component of NEHRP includes targeted research into the record of tsunami-generating earthquakes, and the USGS Coastal and Marine Geology Program carries out research on characterization of tsunami sources, tsunami generation modeling, and post-event surveys of coastal flooding, sediment transport, ecological impacts, and other tsunami consequences. NSF has established a tsunami wave tank facility within the Network for Earthquake Engineering Simulations that provides a facility to study the impacts of tsunami forces on structures.

The National Aeronautics and Space Administration supports tsunami research through ongoing research related to sea level change, oceanography and earthquakes.

FEMA funds two earthquake consortia that also address tsunami issues: The Cascadia Region Earthquake Workgroup (CREW) and the Western States Seismic Policy Council (WSSPC). CREW seeks to develop private/public partnerships that foster a culture of mitigation to improve the region's ability to withstand damaging earthquakes and tsunamis. WSSPC establishes consensus policies on earthquake and tsunami issues.

Needed actions. The research needs identified above should be pursued by agencies and coordinated through the National Tsunami Hazard Mitigation Program. In addition, a strategic plan for tsunami research in the United States should be developed to include periodic review of ongoing research efforts and identification of research gaps. Areas of research that, given immediate attention, will have the greatest impacts in the near term also should be identified.

Roles and responsibilities.

Agencies working through the National Tsunami Hazard Mitigation Program – coordinate existing and proposed agency research efforts, conduct a tsunami research review, and develop a strategic research plan.

4. INTERNATIONAL COOPERATION

The recent events across Southern Asia demonstrate that tsunamis can have global implications, engendering economic, political and social consequences felt around the world. The United States recognizes that the establishment of a U.S. national warning system has international implications and linkages to processes in the international arena, and that the United States has much to offer and to gain in terms of provision of technical expertise, data, and capacity building for the establishment of detection, forecasting and warning systems for natural hazards in all regions at risk. Through effective international cooperation, the United States can increase national tsunami safety and reduce international losses, thus enhancing global stability and minimizing future costs of aid and recovery.

4.1 CURRENT CAPABILITIES (ONGOING INTERNATIONAL PROCESSES)

Intergovernmental Oceanographic Commission (IOC). Following the tragic events of the Indian Ocean earthquake and tsunami, members of the international community called for prompt establishment of a tsunami early warning system in the region. Following several international meetings, the United Nations Educational, Scientific, and Cultural Organization's Intergovernmental Oceanographic Commission (UNESCO IOC) was given the lead role in coordinating UN agency activities for development of a tsunami warning system. UNESCO IOC is holding a series of technical meetings to draft design and work plans and a timetable for development of a tsunami warning system in the Indian Ocean region, acknowledging the importance of an all-hazard approach and recognizing the need for warning systems in other regions.

The existing Tsunami Early Warning System in the Pacific Ocean region is coordinated by UNESCO IOC. Efforts to establish a tsunami early warning system in the Indian Ocean and other regions can benefit from the experience and expertise of the UNESCO IOC, not only in coordinating the Pacific Early Warning System, but also in addressing the full range of ocean and coastal problems through the sharing of knowledge, information and technology among countries.

GEO/GEOSS. In parallel with the international process to create a global tsunami warning system, for which UNESCO IOC has coordinating responsibility, the Group on Earth Observations (GEO) has committed to support the creation of an all-hazard warning system. The processes are linked, as tsunami warning will be part of the all-hazard warning system.

The purpose of GEO, an international effort with over 60 members, is to develop and implement the Global Earth Observation System of Systems (GEOSS). GEOSS seeks to link thousands of technological assets into a comprehensive global observation system, improving our ability to address critical environmental and socio-economic concerns. GEOSS is focused on delivering timely, quality information as a basis for sound decision making in nine societal benefit areas, including reducing loss of life and property from natural and human-induced disasters. GEOSS is also concerned with identifying gaps in observations, such as that for a tsunami warning system in the Indian Ocean, and works with other countries and international agencies to fill those gaps. Key national and intergovernmental operators of Earth observation systems and UN agencies with responsibilities in disaster mitigation/development participate in GEO.

Other related international activities. A number of other intergovernmental organizations and regional bodies are playing an active role in the development of tsunami warning systems and/or all-hazard systems in the Indian Ocean and other regions. The World Meteorological Organization is

hosting activities designed to strengthen global telecommunication system (GTS) capabilities in Indian Ocean developing countries, to meet the requirements for a tsunami warning system. This work is complementary to the IOC meetings. The United States supports these activities and is providing personnel to assist with these preliminary assessments, which are due to be completed by July 2005.

The UN International Strategy for Disaster Reduction (ISDR) and ISDR Secretariat are policy guidance bodies. The ISDR Framework, as a strategy or set of guidelines, is relevant in discussions on disaster risk reduction and how that relates to developing "all-hazard" warning systems. The United States supports the ISDR Framework in its advisory role, under the supervision of the Emergency Relief Coordinator – to identify best practices and lessons learned and ensure dissemination of this information to national and local authorities, throughout the UN system, and to the development community at large (bilateral development agencies, World Bank, regional development banks, etc).

A number of other entities are engaged in discussions relating to warning systems and the United States participates in these discussions, as appropriate, including: the UN World Summit on the Information Society, e.g., discussions of common protocols for communication of warnings and the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization, which operates seismic sensor systems and is discussing ways it might provide real-time seismic data in support of a tsunami or earthquake warning systems. The Asia-Pacific Economic Cooperation and other Asian regional organizations are hosting a variety of meetings and workshops to facilitate development of a tsunami warning system in the Indian Ocean.

4.2 NEEDED ACTIONS

The Indian Ocean tsunami produced measurable tide-level changes along the east coast of North America as far north as Nova Scotia—further indication that tsunamis are global in nature. Addressing regional efforts to develop tsunami early warning systems are beneficial to our understanding of this phenomenon and our ability to better predict the impact of geologic activity on United States coastlines. Additionally, our efforts to improve foreign governments' capabilities to interpret data, issue warnings, and take emergency measures to protect their citizens enables our foreign assistance to be used to promote democracy, economic growth and stability, rather than for disaster response and emergency assistance.

The United States strongly supports the international development of a global tsunami detection, forecasting, and warning network that also will contribute to an all-hazards warning system. The United States supports the lead coordinating role of the UNESCO IOC in development of a global tsunami warning network and actively participates in the international process to develop such a system, including for the Indian Ocean region. The United States will work closely with UNESCO/IOC and other interested parties to enhance and expand global tsunami warning systems and to implement recommended tsunami hazard assessment, detection, forecasting, and warning systems in regions at high risk. The United States will contribute technical expertise as well as real-time seismic and sea level data to any national or regional tsunami warning system effort. For tsunami-affected countries, the United States also will provide assistance to improve communication, warning and public education to warn populations threatened by natural disasters. The United States will continue to encourage activities in the Indian Ocean and other regions that enhance the resilience of populations and infrastructure to disasters (e.g., maintaining mangroves

and coral reefs; implementation of disaster-resilient building codes).

The United States will work with the UNESCO IOC to ensure that the United States national system is interoperable with the IOC Sub-commission for the Caribbean and Adjacent Regions (IOCARIBE) plan for developing a tsunami warning system in the Caribbean basin. The United States National Tsunami Warning System will be part of the international tsunami warning system coordinated by UNESCO IOC.

The United States supports GEO as the intergovernmental forum for coordinating activities to expand multi-hazard capabilities for disaster reduction at national, regional and international levels, with particular focus on reducing loss of life and property from disasters. The United States engages in other international fora on tsunami and disasters, as appropriate.

Indian Ocean Tsunami Warning System. The United States has pledged to support the multinational effort to establish an Indian Ocean tsunami warning system. USAID is coordinating a multi-agency, integrated USG program of assistance to strengthen disaster warning and response capabilities through international, regional, national, and sub-national interventions. The Pacific Tsunami Warning Center, operated by NOAA, and the Japan Meteorological Agency are providing interim tsunami advisory information to authorized contacts in the Indian Ocean region, pending the establishment of a full-fledged system.

Data and information sharing. A geographically widespread network of sensors and buoys is key to obtaining the real-time data necessary for analysis of a tsunami threat and for providing lead-time to countries to take measures and actions to reduce fatalities and economic impacts. Some redundancy or overlapping of data can be beneficial. The United States strongly encourages countries participating in an early warning system to engage in full and open exchange of publicly-funded, unclassified data, recognizing relevant international instruments and national policies and legislation. Data sharing remains a hurdle in developing an Indian Ocean tsunami warning system and in broader efforts to develop regional all-hazard warning capabilities. The United States particularly encourages countries in the Indian Ocean region to enhance or develop mechanisms for real-time sharing of seismic and tide gage data.

4.3 ROLES AND RESPONSIBILITIES

International efforts to reduce the risk of tsunamis are inherently more complex than domestic risk reduction. Although scientific and technical issues may be similar, the funding and diplomatic requirements to reduce tsunami risk globally require the participation and resources of the U.S. State Department and the U.S. Agency for International Development for both legal and practical reasons. The primary source of scientific and technical expertise in international efforts should continue to be the National Tsunami Hazard Mitigation Program; the expertise applied within the United States should also be applied globally to assure the same level of technical expertise, and to ensure that a U.S. system is compatible with global systems. As with other international scientific efforts, however, tsunami risk reduction conducted with other nations or international organizations must be conducted within the diplomatic framework provided by the State Department.

The United States has existing agreements and relationships with many nations and organizations that may be profitably used to expedite new work on tsunamis. For example, the United States has long and productive relationships with several UN agencies and programs involved in tsunami risk

reduction. In addition, numerous science and technology agreements exist with other nations that may be useful in facilitating future tsunami research and risk reduction efforts. International tsunami risk reduction work, including such things as production and deployment of buoys, capacity building, establishment of warning systems, and scientific collaboration, should build upon these existing channels of cooperation. In addition, new agreements and new relationships with international partners can be built upon, and coordinated with, existing agreements.

5. ACTIONS FOR SUSTAINED TSUNAMI RISK REDUCTION

A partnership between federal agencies and states concerned with public safety and loss reduction was established in 1997. Known as the National Tsunami Hazard Mitigation Program, this partnership seeks to reduce tsunami risk to United States coastlines through hazard assessment, warning guidance and mitigation. These elements, along with research and international cooperation, will form an effective and comprehensive means to develop tsunami-resilient communities in the United States.

The National Tsunami Hazard Mitigation Program, a partnership involving relevant Federal agencies and coastal states, provides the organizational framework needed to execute the President's tsunami initiative in the near-term and shall develop, coordinate and sustain an effective and efficient tsunami risk reduction effort in the United States over the long term. As the National Tsunami Hazard Mitigation Program develops, coordinates and sustains an effective and efficient tsunami risk reduction effort in the United States, it may be expanded as necessary and should draw upon expertise in other ongoing hazards reduction programs. The Subcommittee on Disaster Reduction should be briefed on an annual basis and shall partner with the National Tsunami Hazard Mitigation Program to consider options for a sustained national tsunami risk reduction effort. Specific actions called for in this plan are:

- Develop standardized and coordinated tsunami hazard and risk assessments for all coastal regions of the United States and its territories.
- Improve tsunami and seismic sensor data and infrastructure for better tsunami detection and warning.
- Enhance tsunami forecast and warning capability along our coastlines (Pacific, Atlantic, Caribbean, and Gulf of Mexico) by increasing the number of Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys, tide gauges, and seismic sensors feeding real-time data into on-line forecast models.
- Ensure interoperability between U.S. national system and other regional tsunami warning systems.
- Provide technical expertise and assistance, as appropriate, to facilitate development of international tsunami and all-hazard warning systems, including for the Indian Ocean.
- Encourage data exchange and interoperability among all regional tsunami and all-hazard warning systems, such as The Intergovernmental Oceanographic sub-commission for the Caribbean (IOCARIBE).
- Promote development of model mitigation measures and encourage communities to adopt construction, critical facilities protection and land-use planning practices to reduce the impact of future tsunamis.
- Increase outreach to all communities, including all demographics of the at-risk population, to

raise awareness, improve preparedness, and encourage the development of tsunami response plans.

- Conduct an annual review of the status of tsunami research and develop a strategic plan for tsunami research in the United States.

APPENDIX A: KEY TERMS

All-hazards approach—an integrated hazard management strategy that incorporates planning for and consideration of all potential natural and technological hazards, including terrorism.

Built environment—the Nation's constructed facilities, buildings, transportation, and industrial infrastructure systems.

Critical infrastructure—the physical and cyber-based systems that are essential to the minimum operations of the economy and government.

Disaster—a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.

Disaster risk—the chance of a hazard event occurring and resulting in disaster.

Hazard—a natural or human-caused threat that may result in disaster when occurring in a populated, commercial, or industrial area.

Hazard event—a specific occurrence of a hazard.

Hazard mitigation—any action taken to reduce or eliminate the long-term risk to human life and property from natural hazards.

Hazard risk—the chance of a hazard event occurring.

Natural disaster—a disaster that results from a natural hazard event.

Natural hazard—a hazard that originates in natural phenomena (e.g., hurricane, earthquake, tornado).

Resilience/resilient—the capacity of a system, community, or society potentially exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Risk—the probability of harmful consequences or expected losses (death and injury, loses of property and livelihood, economic disruption, or environmental damage) resulting from interactions between natural or human-induced hazards and vulnerable conditions.

Technological disaster—a disaster that results from a technological hazard event.

Technological hazard—a hazard that originates in accidental or intentional human activity (e.g., oil spill, chemical spill, building fires, terrorism).

APPENDIX B: REFERENCES

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APPENDIX C: ABOUT THE NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

ABOUT THE NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

The National Science and Technology Council (NSTC), a cabinet-level council, is the principal means for the President to coordinate science and technology policies across the Federal Government. NSTC acts as a virtual agency for science and technology to coordinate the diverse parts of the Federal research and development enterprise.

An important objective of the NSTC is the establishment of clear national goals for Federal science and technology investments in areas ranging from information technologies and health research to improving transportation systems and strengthening fundamental research. This council prepares research and development strategies that are coordinated across Federal agencies to form an investment package that is aimed at accomplishing multiple national goals.

To obtain additional information regarding the NSTC, contact the NSTC Executive Secretariat at (202) 456-6101.

ABOUT THE COMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES (CENR)

The purpose of the Committee on Environment and Natural Resources (CENR) is to advise and assist the NSTC to increase the overall effectiveness and productivity of Federal research and development efforts in the area of the environment and natural resources. This includes maintaining and improving the science and technology base for environmental and natural resource issues, developing a balanced and comprehensive research and development program, establishing a structure to improve the way the Federal Government plans and coordinates environmental and natural resource research and development in both a national and international context, and developing environment and natural resources research and development budget crosscuts and priorities.

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- Samuel Williamson (NOAA)
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ABOUT THE SUBCOMMITTEE ON DISASTER REDUCTION

Mitigating natural and technological disasters requires a solid understanding of science and technology, rapid implementation of research information into disaster reduction programs and applications, and efficient access to diverse information available from both public and private entities. The Subcommittee on Disaster Reduction provides a unique Federal forum for information sharing, development of collaborative opportunities, formulation of science- and technology-based guidance for policy makers, and dialogue with the U.S. policy community to advance informed strategies for managing disaster risks.

Chartered in 1988, the Subcommittee on Disaster Reduction is a subcommittee of the Committee on Environment and Natural Resources, an element of the President's National Science and Technology Council. The Chair and Vice Chair are each selected by the White House Office of Science and Technology Policy and serve a three-year term. The heads of relevant agencies and departments annually designate lead representatives to the SDR.

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ABOUT THE UNITED STATES GROUP ON EARTH OBSERVATIONS

An Interagency Working Group on Earth Observations was chartered by the Committee on Environment and Natural Resources for the purpose of developing the Strategic Plan for the U.S. Integrated Earth Observation System, and to provide U.S. contributions to the Global Earth Observation System of Systems (GEOSS). The Interagency Working Group's charter expired in December, 2004, and the working group has been replaced with a standing subcommittee under the Committee on Environment and Natural Resources, the United States Group on Earth Observations (US GEO).

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National Science and Technology Council

A Joint Report of the Subcommittee on Disaster Reduction and the United States Group on Earth Observations

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